Fuel Cell Catalyst

Fuel Cell Catalyst is a quarterly newsletter linking government and industry fuel cell activities.

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"If customers find value in using fuel cells for on-site power generation . . . then our business is the supply of a variety of energy services and products."

Kerry Bowers, end-use manager, Southern Company, quoted on Office.com, Oct. 20, 2000

Carbonate Fuel Cells

Efficiency and Fuel Flexibility for Power Generation

Fuel cell technology is rapidly advancing with substantial investments of private sector and public sector financial and intellectual capital. Fuel cells have proven themselves capable of providing superior energy efficiency and environmental performance, and yet, their adoption for widespread use is still uncertain due to high initial capital cost.

The carbonate fuel cell, often referred to as the molten carbonate fuel cell (MCFC), is one of the fuel cell technologies that has proven efficiency and environmental performance. In addition, significant reductions in carbonate fuel cell capital cost are expected in the next few years. In particular, the use of carbonate fuel cells in the distributed power market could offer an ideal solution to increased energy demands with concurrent expectations for reliability and environmental sensitivity.

The carbonate fuel cell concept involves conduction of carbonate ions ($CO_3^=$) within an immobilized mixture of molten carbonate salts. Other cell components are based on nickel and stainless steels, which contribute to initial capital cost, but, are significantly less expensive than the precious metal catalysts used in lower temperature fuel cells. Since the charge carrier is an oxidant, several fuel species can be oxidized within the anode compartment leading to inherently greater fuel flexibility. To-date, carbonate fuel cells have been operated on hydrogen, carbon monoxide, natural gas, propane, landfill gas, marine diesel, and simulated coal gasification products.

The typical operating temperature of a carbonate fuel cell is around 650°C. This temperature is almost ideal from the system perspective, since it allows higher Nernst potential (ideal Nernst potential increases with decreasing temperature) while still providing high temperature thermal energy sufficient to sustain and support reformation chemistry. Thus carbonate fuel cell system designs typically contain an internal reformer. The carbonate fuel cell demonstrations to-date, have therefore been able to show the highest fuel-to-electricity conversion efficiencies (>50%) of any stand-alone fuel cell type.

The primary developer of this type of fuel cell is FuelCell Energy Corporation, the developer and manufacturer of the Direct FuelCell™ concept. FuelCell Energy has demonstrated carbonate fuel cells from 10kW to 2MW of electrical output on a variety of fuels. Hitachi and IHI are also developing carbonate fuel cells for stationary power and have recently, successfully demonstrated the technology in Kawagoe, Japan. Ansaldo Ricerche has also demonstrated a 100kW carbonate fuel cell in Milan, Italy. Carbonate fuel cell technology is more fuel flexible than lower temperature fuel cell technologies and is well suited to marine, military, and traction applications.

The high temperature thermal effluent of a carbonate fuel cell allows significant cogeneration and/or integration with a heat engine cycle, typically called a "hybrid." Several carbonate fuel cell hybrid systems with fuel-to-electricity efficiencies greater than 70% have been conceptualized with some under development today. The system currently in development by FuelCell Energy and Capstone Turbine in Danbury, Connecticut is the prime example.

The high efficiency, low emissions, and fuel flexibility features of carbonate fuel cells together with recent demonstrations of robust and reliable operation, and the potential for dramatic cost reductions make carbonate fuel cells a key emerging technology for meeting future energy demands.

JACOB BROUWER, PH.D., ASSOCIATE DIRECTOR, NATIONAL FUEL CELL RESEARCH CENTER

Financing Fuel Cell Installations

While several technical hurdles remain, it is not too early to begin thinking about the business administration of fuel cells. It is no secret that the market is concerned with the high capital costs of fuel cells, as well as the risk exposure of new technology. Financial tools such as leasing and asset management that target the energy consumer could prove to be a key piece of the fuel cell commercialization puzzle.

Leasing offers various benefits including cash management, technology risk avoidance, off balance sheet financing, income tax benefits and asset management services.

Leasing is an effective tool for avoiding many risks of asset ownership. Under leasing, the inherent risks of innovative technology and the threat of technology obsolescence are placed on the financing company and not the end user. Leasing can further minimize risk by providing companies with a more flexible tool for upgrade options, equipment rollover, and return provisions.

From a financial reporting perspective, leasing provides several different benefits such as off balance sheet financing, improved earnings, and better financial ratios. If a lease is classified as an operating lease, it is not capitalized in the financial statements and so neither an asset nor a liability appears on the lessee's balance sheet. Only a lease rental expense appears on the lessee's income statement.

Income tax motivations are another reason companies elect to lease equipment. A lessee may have insufficient tax capacity to benefit from accelerated tax depreciation of the asset. However, depending on the lease structure, the lessor may be considered the tax owner of the equipment and thus receive the tax benefits such as tax deferral which can be passed on to the lessee in the form of lower lease payments.

The integrated solution of leasing from inception to disposition of the asset is increasingly important as companies desire to focus more on the provision of goods and services rather than on the technology needed to power their building and machines. Innovative leasing tools allow an end user access to new technology with lower up-front capital spent, minimized equipment risk, and more flexible financial reporting and decision making.

REBECCA JUDIS, MANAGER, NEW TECHNOLOGIES, DANA COMMERCIAL CREDIT

Credit Aspects of DG

Much of the attention focused on companies involved in distributed generation (DG) and new utility technologies has come from an equity perspective. Standard & Poor's believes that the debt markets will begin to play an important role in the development of these companies. Standard & Poor's analyzes both the technologies and the companies that employ them, with regard to the credit quality of these companies themselves, as a market for their debt develops, and the credit implications for traditional utility and generation companies.

The natural progression for emerging industries is to first get seed money from venture capitalists who encourage, or more likely, require, subsequent common stock IPOs or investment from interested corporations. Several DG and new utility technology companies have moved beyond the venture capital stage and have accessed the equity capital markets, including Plug Power Co., Ballard Power Systems, Evergreen Solar Co., Proton Energy Systems, Capstone, American Superconductor, and, most recently, Beacon Power. Because of that need for money, Standard & Poor's believes the next financial phase for this industry, involving bank and bond investment, could be coming.

Indeed, FuelCell Energy, another public company, has filed an SEC shelf registration requesting authorization to issue both common stock and capital market debt. This event is an indication of the potential for future bond deals by these companies.

The importance of the debt markets to this new industry sector should not be overlooked. Besides being another avenue to money, it is a group of investors that give credibility to emerging industries and companies, because they actually want their money back. There is a significant element of speculation, but the presence of bankers and bond investors suggests viability for this industry. It is, perhaps, just a matter of time before the debt markets get involved.

When it comes to analyzing the credit of a new utility technology company, Standard & Poor's analyzes it like any other industrial manufacturing firm. These companies (at least initially) are relatively high-risk investments. They will not be like a traditional electric utility. They will not have a monopoly franchise, and they will not earn regulated returns. Instead, they will face major competition, and have to fight for sales every day. Credit ratings likely will be in the 'speculative grade' category, ranging from 'BB' (less speculative) to 'CCC' (more speculative).

"…the presence of bankers and bond investors suggests viability for this industry."

The best companies probably will have the best technology. But without financial liquidity, even the best technology can fizzle. Over time, Standard & Poor's expects the best firms to have the highest market shares, but also develop product and geographic diversity.

DG companies are developing many different types of technologies. Each company is trying to fill a certain customer niche and is likely to serve some power consumers better than others. Standard & Poor's believes the best firms will ultimately offer an array of products that cover a broad spectrum of customers. Naturally, this suggests industry consolidation someday.

In conclusion, the elements are visible for this new energy sector to grow and have an impact on the utility industry. Standard & Poor's will continue to closely follow new utility technology developments, so that an accurate assessment of the impact on incumbent utility credits can be made. Standard & Poor's also anticipates assigning credit ratings to individual companies in this new industry.

RONALD M. BARONE, DIRECTOR, STANDARD & POOR'S

MCFC State-of-the Art

FuelCell Energy

FuelCell Energy's efforts to develop the carbonate fuel cell followed earlier work to produce an intermediate-temperature fuel cell plant. The latter employed a high-temperature steam reformer to extract hydrogen, and high and low temperature shift converters to reduce carbon monoxide. System efficiency was reduced and plant complexity increased to provide these functions. The intermediate-temperature fuel cell was, in fact, a part of a very high-temperature power plant. In the early 1990's, FuelCell Energy decided to pursue the greater potential of high-temperature fuel cells. Because the electrical energy efficiency and overall thermal efficiency of high temperature fuel cell systems exceeds that which can be achieved with low temperature systems, and because their costs are lower, high temperature fuel cells, with their larger size, have proved to be on-target in terms of product acceptance and market attractiveness.

Demonstrations of plants ranging from 250 kW to 2 MW have validated their efficacy and advanced beta trials are now underway, using a variety of fuels and plant configurations. New projects have been contracted with the Los Angeles Department of Water & Power (three power plants), the Southern Company and Alabama Municipal Electric Authority, Japan's Marubeni Corporation (five plants), Germany's DaimlerChrysler, Global Energy (for a blended coal-gas/municipal waste-fueled 2 MW power plant), and the U.S. Department of Energy (for a coal-bed methane-fueled power plant). A project for a 1 MW plant using municipal digester gas fuel in Washington State is scheduled to commence operations in 2002.

Mahmud Chaudhry, Los Angeles Department of Water Power's Assistant General Manager – Distribution said, "These fuel cell power plants will expand the important role of fuel cell power in our Distributed Generation Program. This new program is designed to improve our quality of service by locating small and clean electric generators near our customers' facilities."

From a policy perspective, during the recent presidential campaign both candidates acknowledged the need for new sources of clean energy technology, including alternative energy and clean-coal technologies. High temperature fuel cells meet both criteria. Beyond stationary systems, the company sees a sizable market for commercial, cruise and naval ships, that is equal in size to that of the U.S. electric utility market. FuelCell Energy is under contract with the U.S. Navy to develop and demonstrate a nominal 0.5 MW marine system using diesel fuel for powering naval vessels. Finally, a high efficiency Direct FuelCell® / gas turbine hybrid system is under development, with a projected system efficiency of greater than 70%, with potential applicability for stationary and marine markets.

ERIC L. SIMPKINS, VICE PRESIDENT BUSINESS DEVELOPMENT, FUELCELL ENERGY, INC.

photo above left: FuelCell Energy's 250 kW Direct FuelCell stack in final assembly.

Marketing/Distribution Agreements Proliferate

You can have the greatest product in the world, but if no one knows about it, what good is it? Fuel cell developers have realized that, and have been busy signing agreements with marketing and distribution companies around the world.

Most fuel cell developers are just that, fuel cell developers – engineers and scientists who have come up with a great product. As that product nears commercialization, the fuel cell developers know they will need the help of marketing and distribution experts. Many joint ventures and partnerships have already been formed in anticipation of the commercial launches of fuel cell products. The following are some of the more recent major announcements.

DOMESTIC (U.S.) AGREEMENTS

The biggest proliferation of domestic marketing/distribution agreements has been in the area of fuel cells for residential and small business applications. When Plug Power teamed up with GE Power Systems to form GE Fuel Cell Systems, the joint venture company set about establishing state-specific marketing deals with Flint Energies (Georgia) and New Jersey Resources (New Jersey). Avista Labs announced a joint marketing/installation agreement with Black & Veatch for distribution of its fuel cell units both in the U.S. and internationally. And Dais-Analytic Corporation got a boost from an equity investment by Enron North America, which will support market development, distribution and other field services for the fuel cell developer's products. Larger-sized fuel cells will be marketed domestically by FuelCell Energy through its agreements with Enron North America and PPL EnergyPlus.

INTERNATIONAL AGREEMENTS

Fuel cell companies have also been rapidly establishing international marketing and distribution agreements. GE MicroGen has signed agreements with companies to distribute its fuel cells in Saudi Arabia, Bangladesh, Germany and Japan. Headquartered in Seoul, Clean Energy Technologies Inc. is a new joint venture company that will manufacture, market and distribute stationary power generators in the Asia Pacific region based on Dais-Analytic's fuel cell technology. International Fuel Cells formed a joint venture with Toshiba to develop and market IFC's PEM fuel cell power plants in Japan. FuelCell Energy has partnered with Marubeni for the marketing of fuel cells in Japan.

As fuel cell developers approach the time for commercialization of their products, more of these marketing and distribution agreements can be expected.

BERNADETTE GEYER, EDITOR

Calendar

Electric Power 2001

Baltimore, Maryland, USA - 20-22 March 2001.
Email Craig Moritz at craigm@tradefairgroup.com for more information.

2nd Solid State Energy Conversion Alliance Workshop

Arlington, Virginia, USA - 29-30 March 2001.
See www.netl.doe.gov/events/01conferences/seca/seca01.html for more information.

Small Fuel Cells and Battery Technologies for Portable Power Applications

Washington, DC, USA - 22-24 April 2001. Organized by The Knowledge Foundation. Register online at www.knowledgefoundation.com.

Hannover Fair 2001:

The world fair for Energy Management and Technology GERMANY - 23-28 April 2001. See www.h2fair.de/e/hm01/index.html for more information.

industry notes

Ballard Power Systems has commissioned its first fuel cell manufacturing facility, Plant 1, in Burnaby, British Columbia. The 110,000 square foot facility will enable the company to begin mass-manufacturing commercial fuel cell products for portable power and automotive applications, starting in 2001.

FuelCell Energy has signed an agreement with King County, Washington, to install and operate a 1 MW Direct FuelCell® power plant at the County's South Wastewater Treatment Facility in Renton. The fuel cell will run on digester gas.

New Distributed Energy Resources Center at National Renewable Energy Laboratory will conduct research and provide information needed to develop efficient power generation technologies for distributed generation applications. To support its mission, NREL has planned a new facility to test methods and equipment for interconnecting distributed power systems.

The Cooperative Research Network (CRN) received $200K from the Department of Energy to test and evaluate various pre-commercial residential fuel cell prototypes. CRN is a service of the National Rural Electric Cooperative Association. Under the program, between five and ten models of residential fuel cells from various manufacturers will be placed at consumer sites of participating cooperatives.

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1625 K Street, NW, Suite 725
Washington, DC 20006 USA